



Issue
4

2nd EDITION

ASTROBIOLOGY

The Story of our Search for Life in the Universe



Produced by the NASA
Astrobiology Program to
commemorate 50 years of
Exobiology and Astrobiology
at NASA.

Astrobiology

A History of Exobiology and Astrobiology at NASA

This is the story of life in the Universe—or at least the story as we know it so far. As scientists, we strive to understand the environment in which we live and how life relates to this environment. As astrobiologists, we study an environment that includes not just the Earth, but the entire Universe.

The year 2010 marked 50 years of Exobiology and Astrobiology research at the National Aeronautics and Space Administration (NASA). To celebrate, the Astrobiology Program commissioned this graphic history. It tells the story of some of the most important people and events that have shaped the science of Exobiology and Astrobiology. At only 50 years old, this field is relatively young. However, as you will see, the questions that astrobiologists are trying to answer are as old as humankind.

Concept & Story

Mary Voytek
Linda Billings
Aaron L. Gronstal

Artwork

Aaron L. Gronstal

Script

Aaron L. Gronstal

Editor

Linda Billings

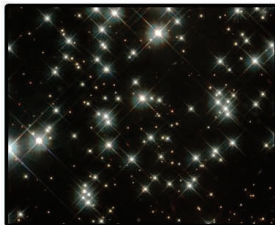
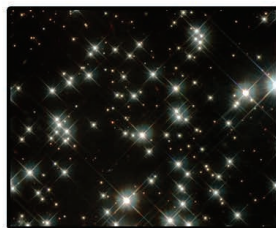
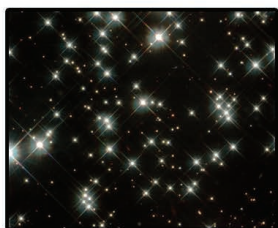
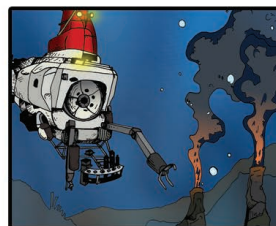
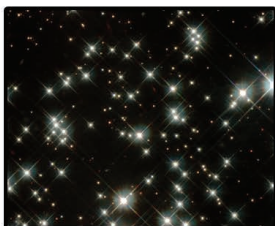
Layout

Jenny Mottar

Special thanks to Leslie Mullen and Daniella Scalice

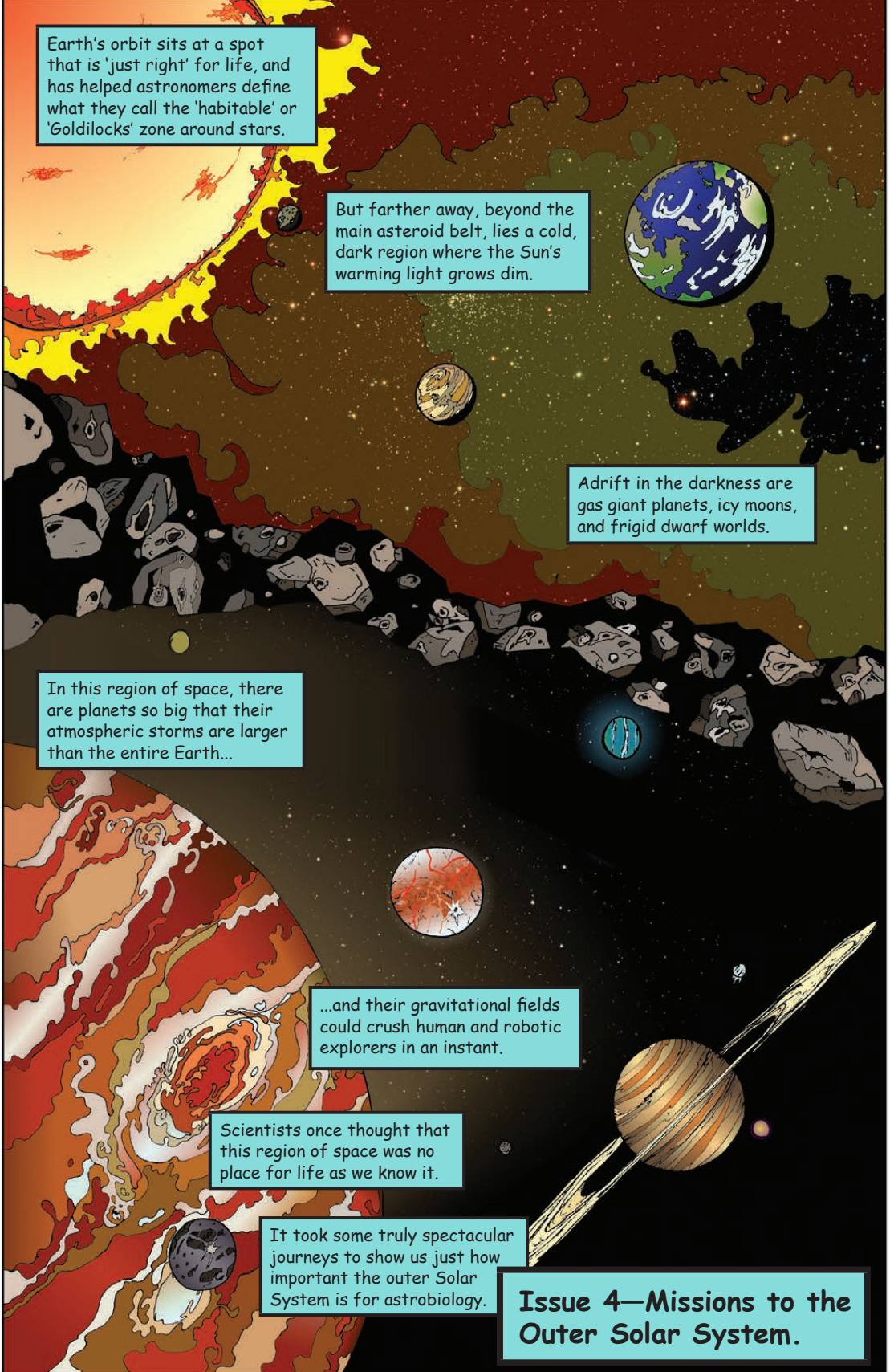
Issue #4

Missions to the Outer Solar System



The year 2010 marked the 50th anniversary of NASA's Exobiology Program, established in 1960 and expanded into a broader Astrobiology Program in the 1990s. To commemorate the past half century of research, we are telling the story of how this field developed and how the search for life elsewhere became a key component of NASA's science strategy for exploring space. This issue is the fourth in what we intend to be a series of graphic history books. Though not comprehensive, the series has been conceived to highlight key moments and key people in the field as it explains how Astrobiology came to be.

-Linda Billings, Editor



Earth's orbit sits at a spot that is 'just right' for life, and has helped astronomers define what they call the 'habitable' or 'Goldilocks' zone around stars.

But farther away, beyond the main asteroid belt, lies a cold, dark region where the Sun's warming light grows dim.

Adrift in the darkness are gas giant planets, icy moons, and frigid dwarf worlds.

In this region of space, there are planets so big that their atmospheric storms are larger than the entire Earth...

...and their gravitational fields could crush human and robotic explorers in an instant.

Scientists once thought that this region of space was no place for life as we know it.

It took some truly spectacular journeys to show us just how important the outer Solar System is for astrobiology.

Issue 4—Missions to the Outer Solar System.

The giant planets of the outer Solar System have fascinated humans for a long time. (1)



They are very far away, but Jupiter and Saturn are so giant that they shine brightly in the night sky.

When Galileo Galilei spotted Jupiter's moons,* it occurred to him that the Universe might not be centered on the Earth. (2)

Hmm...

By the time the space age dawned, scientists like Harold Urey* began to wonder what planetary moons were made of.

"...the Sun remains fixed in the centre of the circle of heavenly bodies, without changing its place..." (3)

"The interiors of objects of similar mass [to the Earth's moon]... must have risen above the melting point of ice in their interiors..."

To truly understand the outer Solar System, astrobiologists needed close-up views that only space missions could provide.

"Hence the water of the Jovian moons must all be at or near their surfaces!"

"In fact, water flows, instead of terrestrial lava flows, may occur from time to time." (4)

*see Issue #1

In 1965, NASA scientist Gary Flandro realized that the planets were in a rare position relative to one another—an event that only occurred every 175 years! (5,6)

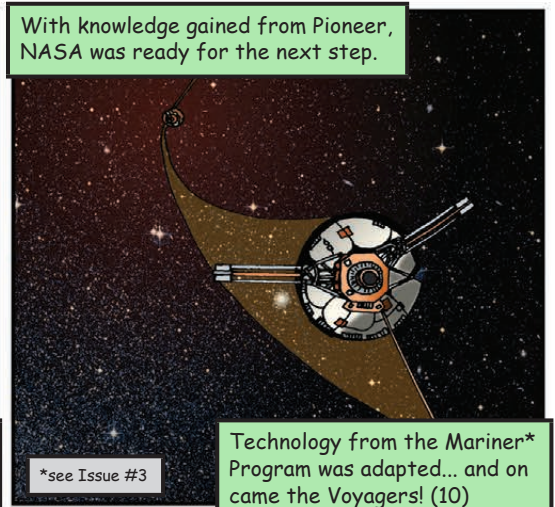
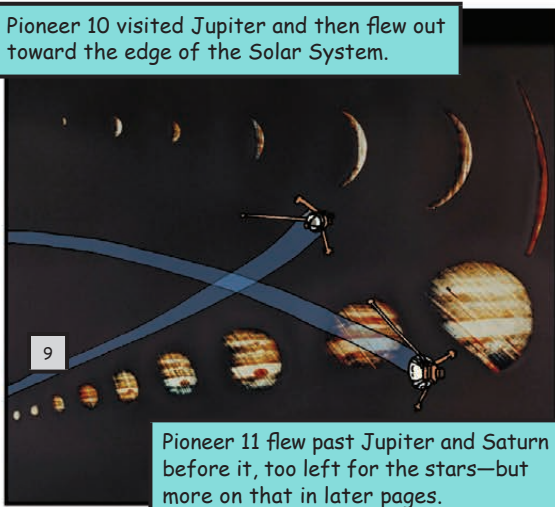
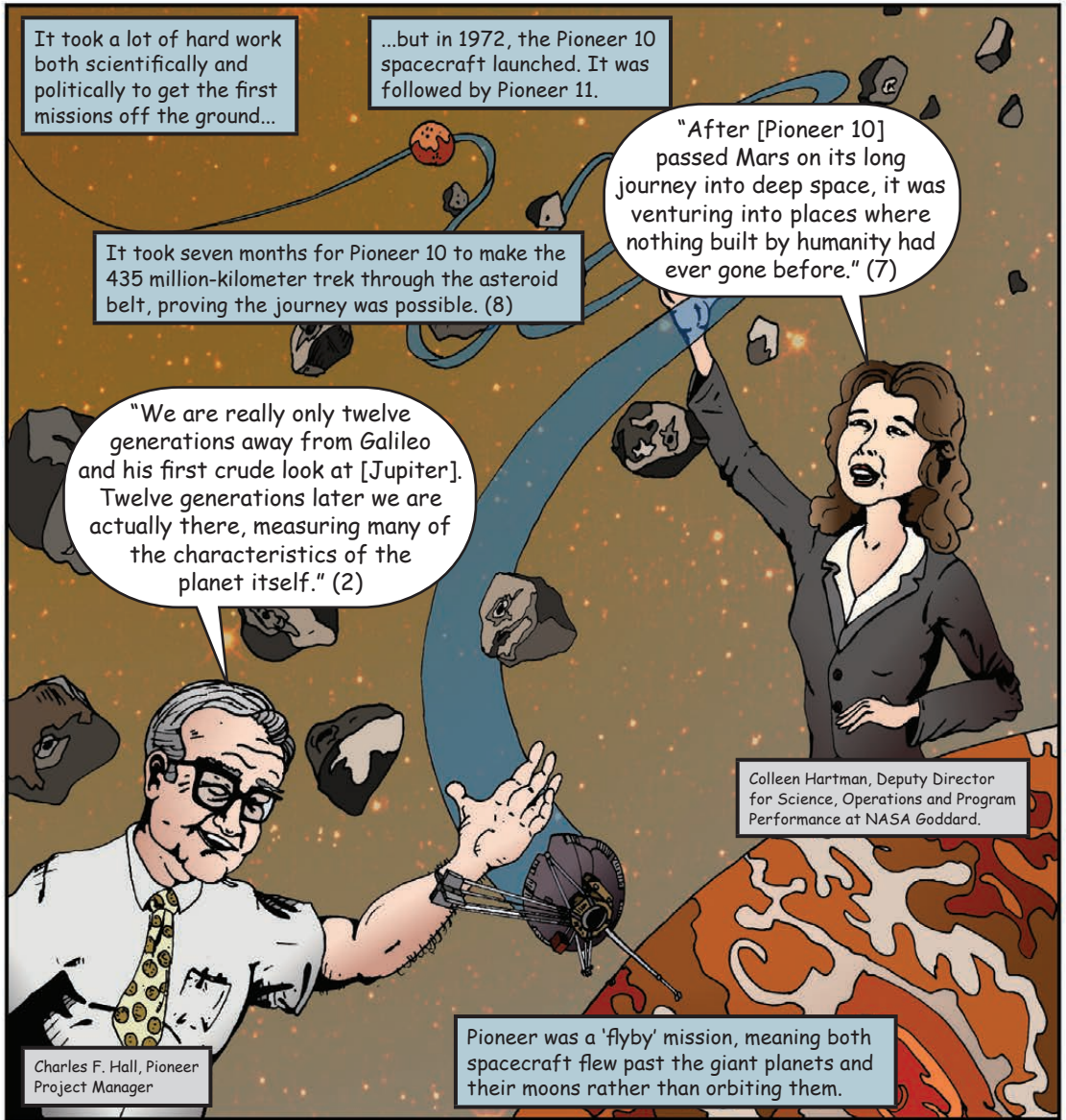
I have an idea.

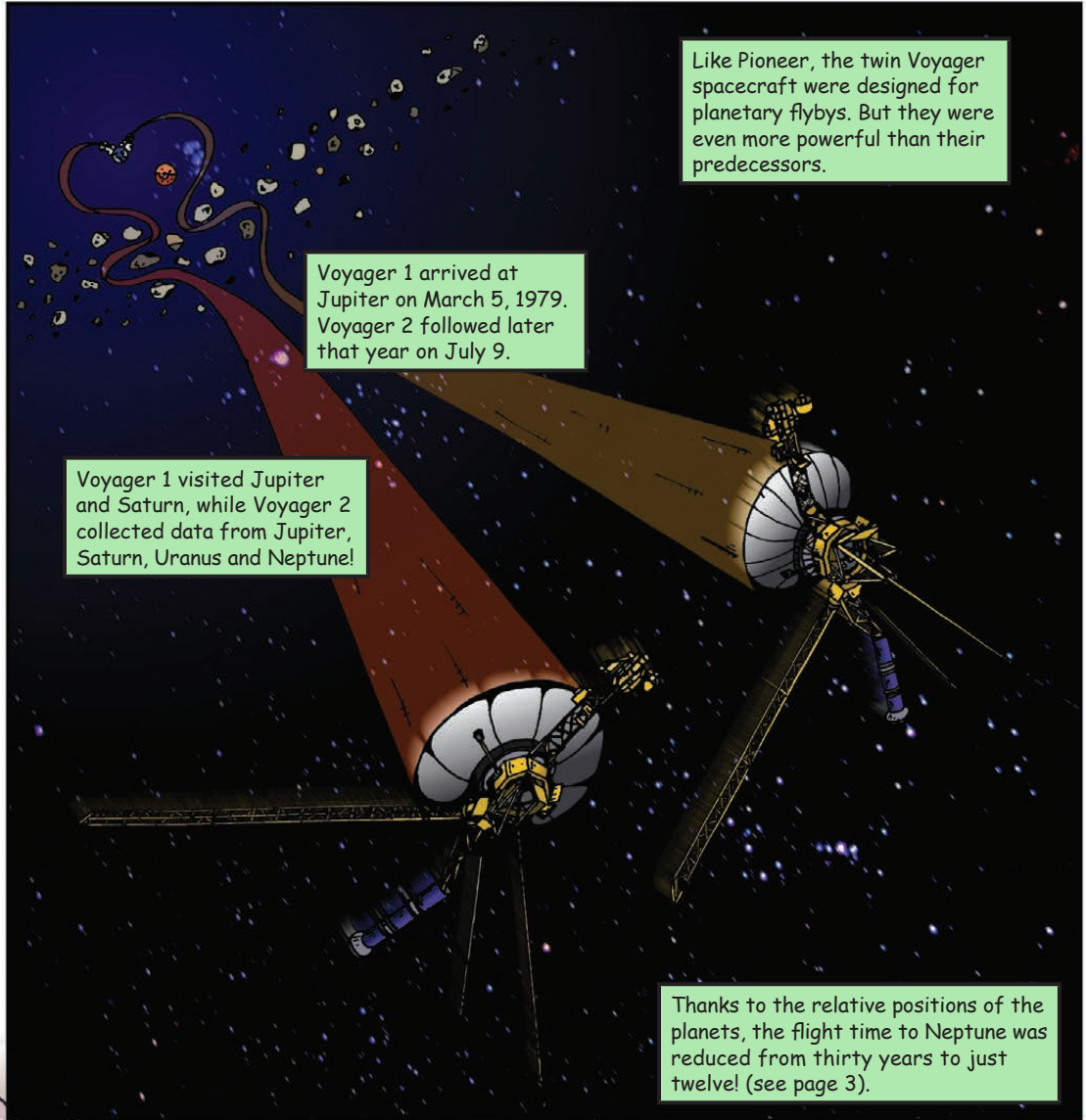
What if we used Jupiter's powerful gravity as a slingshot?

A spacecraft could use the energy to visit all the giant planets in one 'Grand Tour'!



NASA was ready for a game of inter-planetary pinball!



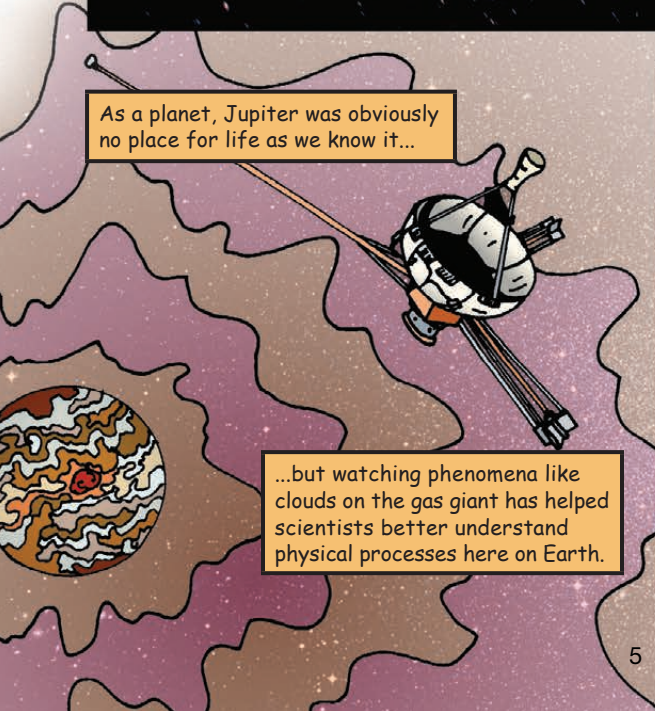


Like Pioneer, the twin Voyager spacecraft were designed for planetary flybys. But they were even more powerful than their predecessors.

Voyager 1 arrived at Jupiter on March 5, 1979. Voyager 2 followed later that year on July 9.

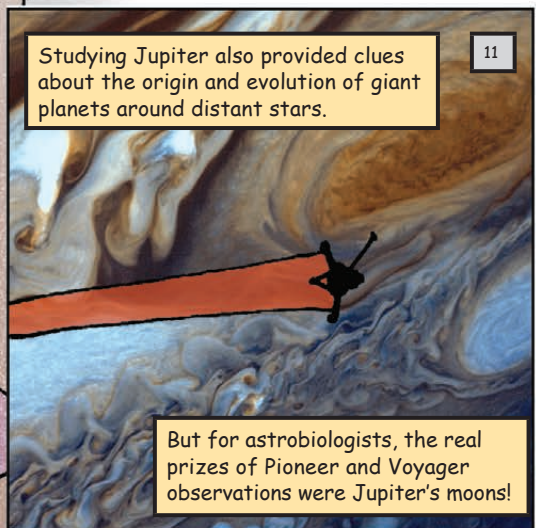
Voyager 1 visited Jupiter and Saturn, while Voyager 2 collected data from Jupiter, Saturn, Uranus and Neptune!

Thanks to the relative positions of the planets, the flight time to Neptune was reduced from thirty years to just twelve! (see page 3).



As a planet, Jupiter was obviously no place for life as we know it...

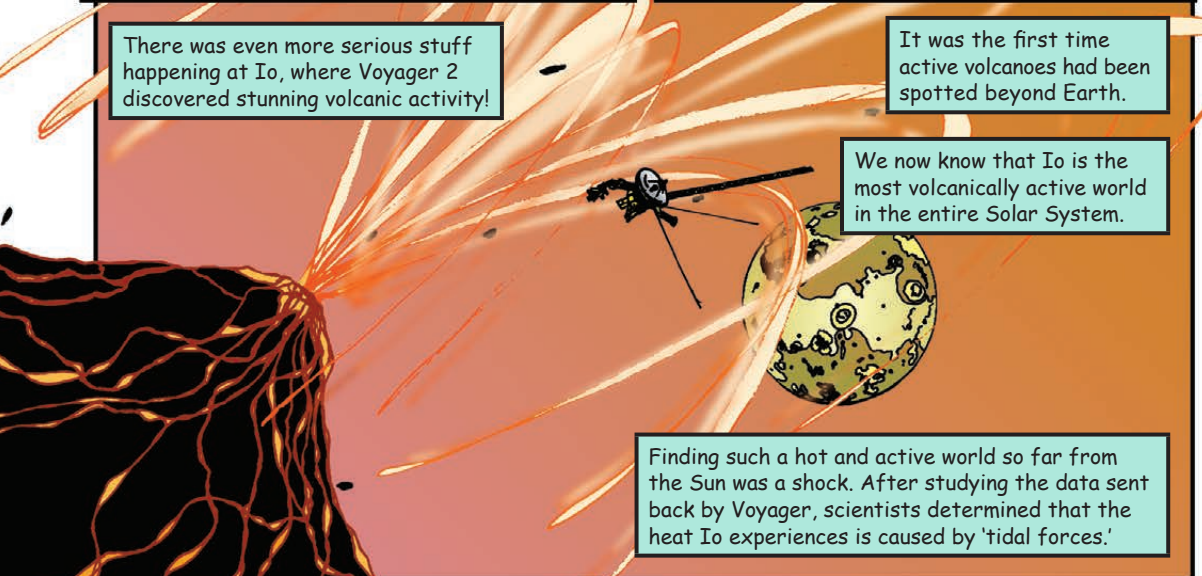
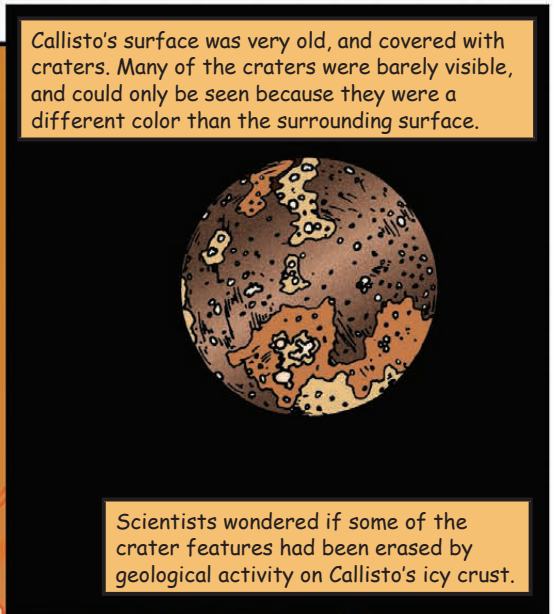
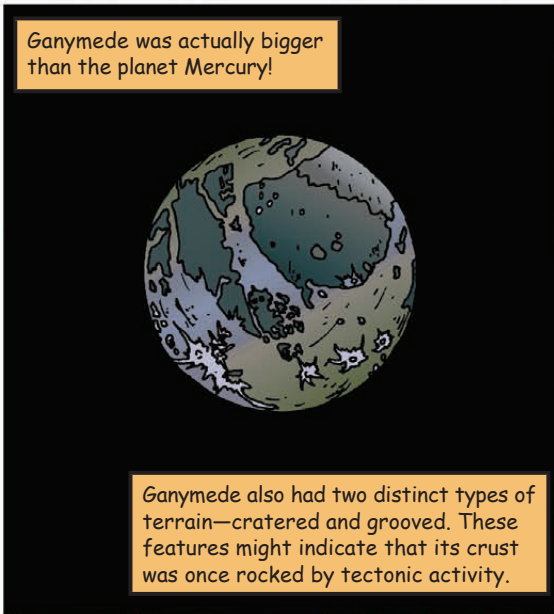
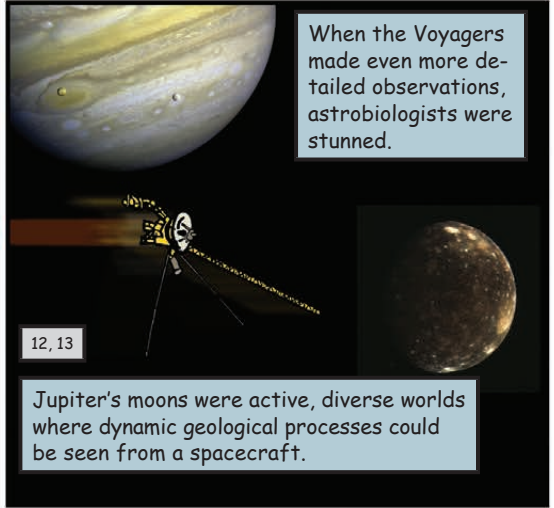
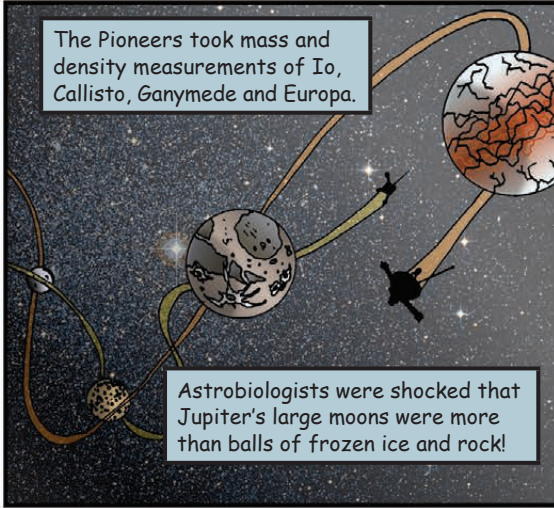
...but watching phenomena like clouds on the gas giant has helped scientists better understand physical processes here on Earth.

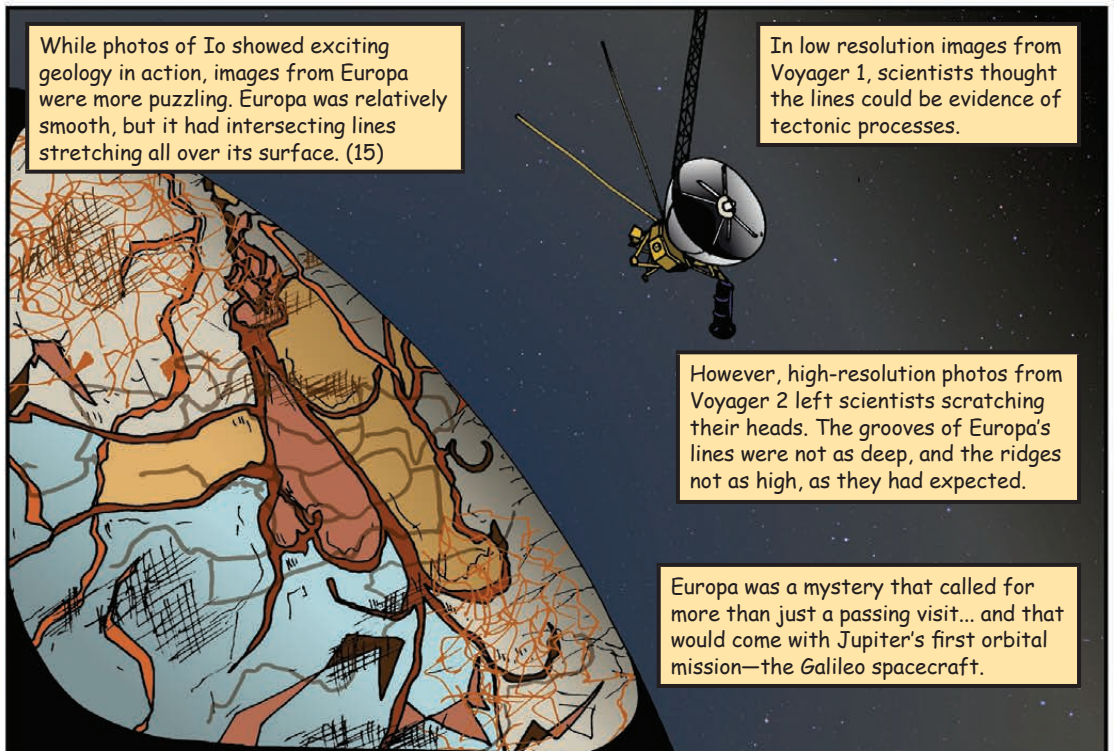


Studying Jupiter also provided clues about the origin and evolution of giant planets around distant stars.

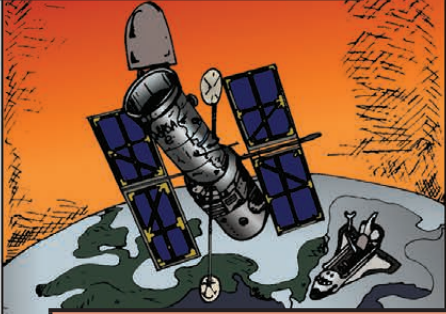
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But for astrobiologists, the real prizes of Pioneer and Voyager observations were Jupiter's moons!





Political pressures almost stopped Galileo before it began. (8)



NASA had also approved the powerful Hubble Space Telescope...

...and taking on these two major programs was a huge strain on the budget. In 1981, Galileo was close to being cancelled.



But the planetary science community made its voice heard, and, in the end, both missions were approved!

"Rarely have I ever seen such a successful lobbying campaign... It was masterfully done." (8)



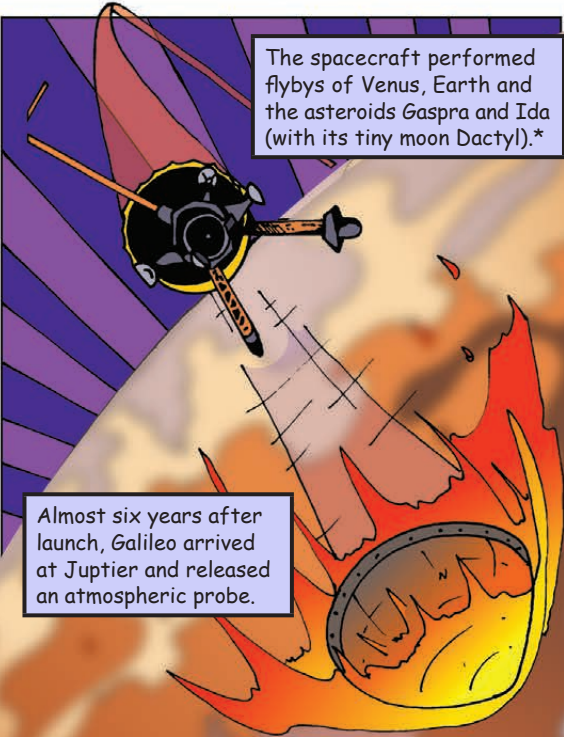
Dick Malow, former staff director of the House HUD-Independent Agencies Appropriations Subcommittee

Galileo left Earth in October 1989 aboard the newly minted Space Shuttle.*



Galileo started work early with two Earth flybys. It spotted a huge impact basin on the far side of the Moon and signs of ancient lunar volcanism.

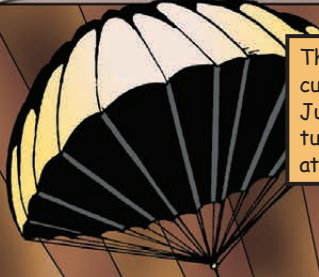
The spacecraft performed flybys of Venus, Earth and the asteroids Gaspra and Ida (with its tiny moon Dactyl!)*



Almost six years after launch, Galileo arrived at Jupiter and released an atmospheric probe.

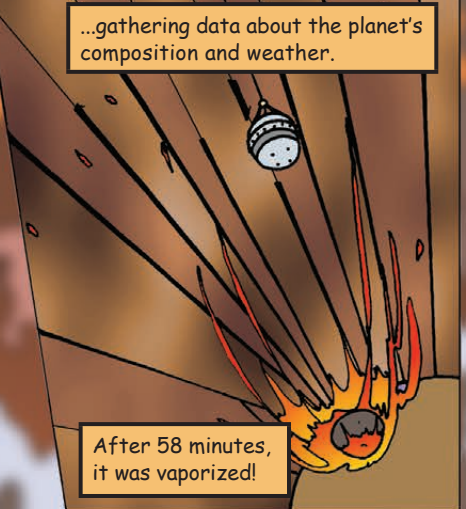
*see Issue #3

The probe cut through Jupiter's turbulent atmosphere...



...gathering data about the planet's composition and weather.

After 58 minutes, it was vaporized!



In July of 1994, Galileo witnessed something spectacular (and unexpected)...

The comet Shoemaker-Levy crashing into Jupiter!

"Galileo was positioned to see the actual impact on the backside and provide images and data concerning exactly the magnitude of those impacts." (16)



Jim Erickson, former Galileo project manager.

Galileo circled through the Jovian system and collected much more data than the Pioneers or Voyagers did on their passing visits.

For instance, Galileo measured Io's temperature and found volcanoes hotter than those on Earth!

But Galileo's real prize for astrobiologists was Europa. Images from the Voyagers were nothing compared to the spectacular world Galileo revealed.

Europa had few craters on its surface. This means that the ice is constantly changing, wiping away the evidence of impacts after they happen.

Although frozen solid, the surface of Europa had large 'ice rafts' the size of cities that appeared to have broken off and floated apart. Galileo also showed that Europa had a thin oxygen atmosphere and ionosphere. (18)

Astrobiologists traced the web of intersecting lines and fissures that covered Europa. They noted the nuances in their colors and the ways in which they reflected light.

Were the cracks fresh ice that was pushed to the surface from below?

Careful examination of the patterns and shapes led scientists to theorize that the icy surface was just a shell resting above a liquid layer deeper down. (19)

Then, Galileo's magnetometer spotted strange directional changes in Europa's magnetic field...

"The direction that a magnetic compass on Europa would point to flips around in a way that's best explained by the presence of a layer of electrically conducting liquid, such as saltwater, beneath the ice."

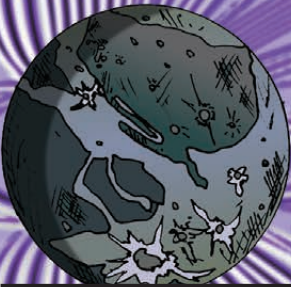
"We have good reason to believe the surface layers of Europa are made up of water that is either frozen or liquid."

"But ice is not a good conductor, and therefore we infer that the conductor may be a liquid ocean." (20)

"It will be interesting to see whether this same type of phenomenon occurs at Jupiter's moon Ganymede." (21)

Margaret Kivelson, principal investigator for Galileo's magnetometer.

Galileo did discover a magnetic field at Ganymede.



...raising questions about what lay beneath the large moon's solid surface. (22)

Similarly, Galileo found a magnetic field at Callisto...



But any ocean on Callisto would have to be extremely deep, because there are large craters all over Callisto's surface.

While the Voyagers were busy putting Europa on the astrobiological map, scientists made a fantastic discovery back on Earth.

Researchers Tjeerd van Anel and Jack Corliss spent six hours exploring the seafloor at 9,000 feet below the Pacific near the Galapagos Islands. (23)

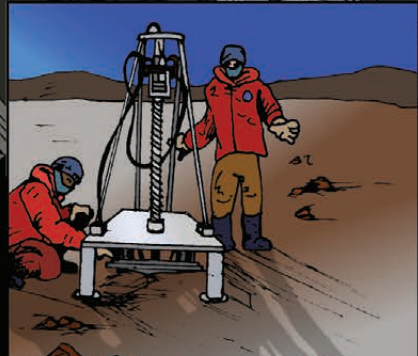
They returned to the surface with samples that stank like rotten eggs.

The smell of hydrogen sulfide led scientists to discover that the depths of Earth's oceans support more life than anyone expected—and some organisms thrived **without** light from the Sun.

We learned of new energy sources, like undersea volcanoes, that supported entire communities of life.*

Scientists began to explore environments on Earth that could be similar to a European ocean—from arctic islands to subsurface Antarctic lakes.

These findings raised many questions that changed our view of habitability and the origin and evolution of life.

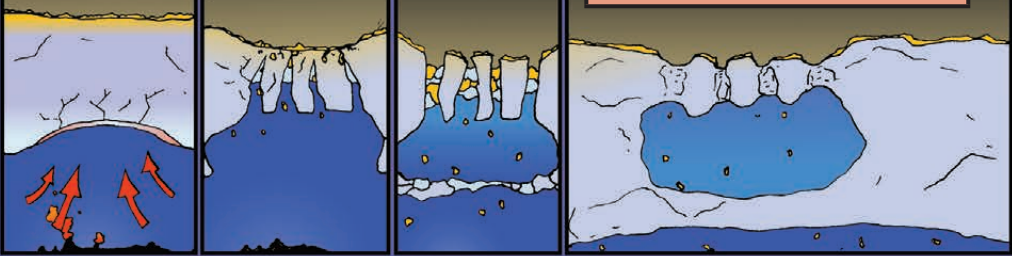


Engineers began developing instruments that could send future missions through the ice of Europa to explore its hidden depths.

*More on this in later issues

Decades after Galileo's launch, astrobiologists are still studying data from the mission and making new discoveries about Europa.

For instance, Earth scientists compared bumpy features on Europa (called chaos terrains) with similar features at Earth's poles. (24)



"One opinion in the scientific community has been if the ice shell is thick, that's bad for biology. That might mean the surface isn't communicating with the underlying ocean."

Based on what we know from Earth, these chaos terrains may indicate that lakes of water exist within the ice of Europa's shell.

Britney Schmidt,
Georgia Tech

Don Blankenship,
University of
Texas at Austin.

"Now, we see evidence that it's a thick ice shell that can mix vigorously and new evidence for giant shallow lakes. That could make Europa and its ocean more habitable." (25)

"This new understanding of processes on Europa would not have been possible without the foundation of the last 20 years of observations over Earth's ice sheets and floating ice shelves." (25)

If material from Europa's surface is mixed through the ice and into the subsurface ocean, as the presence of chaos terrains suggests, Europa could be a much more suitable place for life. (24)

With the discovery that Europa might support habitable environments for life, NASA decided it was too dangerous to leave the Galileo spacecraft stranded in Jupiter orbit when the mission ended.

To ensure Galileo would not accidentally crash into Europa and contaminate the moon, the spacecraft was deliberately destroyed by plunging it into Jupiter's crushing atmosphere in 2003. (18)

Galileo's fiery end completed humankind's explorations at Jupiter for a time.

But there were more surprises waiting at humankind's next stop in the Solar System... Saturn.

Pioneer 11 and the two Voyager spacecraft made passing visits of the splendid, ringed giant.

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Mimas had a crater so huge that scientists thought the impact must have almost broken the moon apart!

These flybys provided data about the planet, its rings and many of its bizarre moons.

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Tiny Enceladus showed evidence of tectonic activity. It was covered in faults and valleys.

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And then there was Titan...

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Although bigger than Mercury, Titan wasn't as big as astronomers expected.

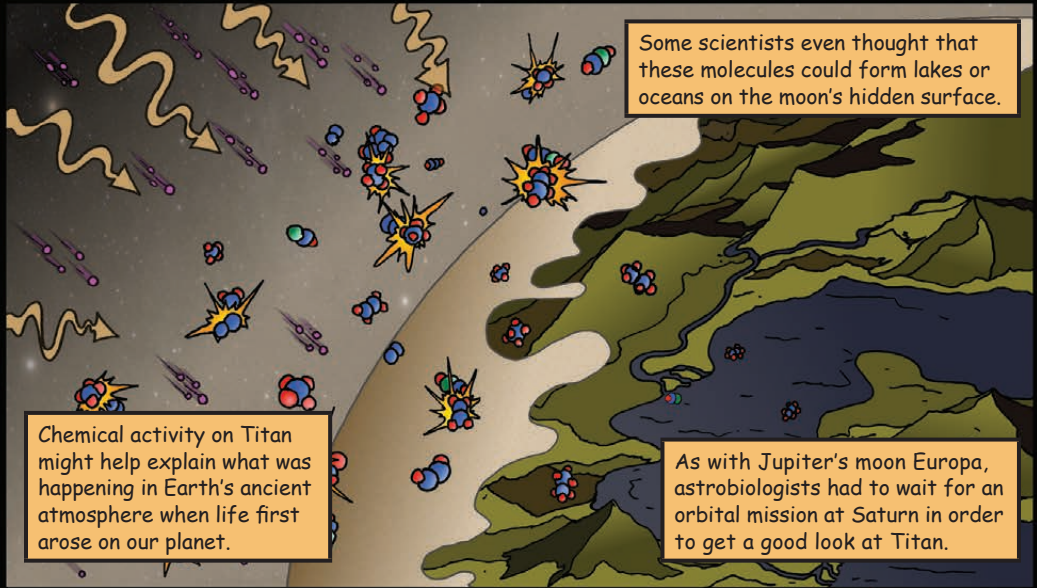
Pioneer and Voyager couldn't see through the Titanic haze, but they still sent back data that stunned astrobiologists.

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It turned out that the moon's thick atmosphere made it look bigger than it actually was.

Scientists began to develop theories about how organic molecules like ethane could be formed in Titan's complex atmosphere.

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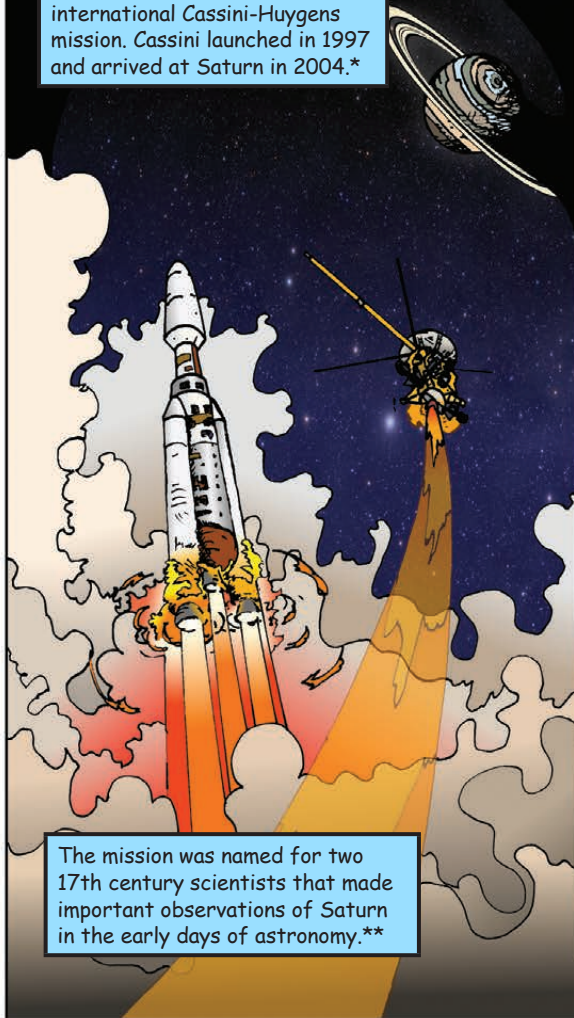
Some scientists even thought that these molecules could form lakes or oceans on the moon's hidden surface.

Chemical activity on Titan might help explain what was happening in Earth's ancient atmosphere when life first arose on our planet.

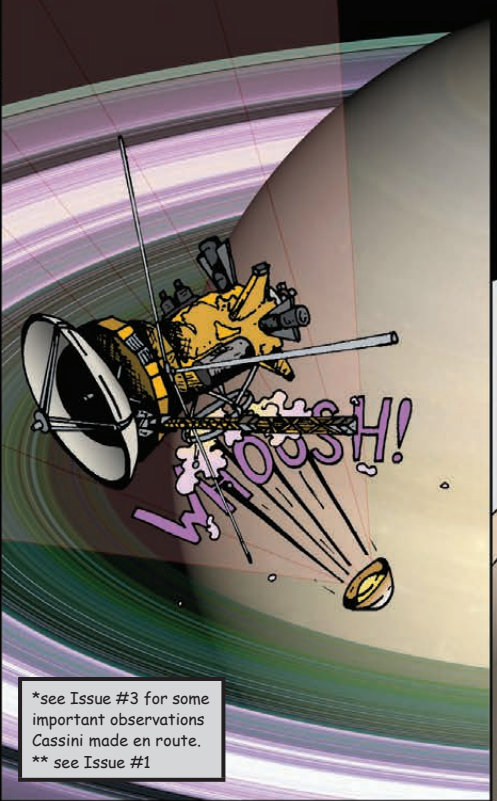
As with Jupiter's moon Europa, astrobiologists had to wait for an orbital mission at Saturn in order to get a good look at Titan.

That chance came with the international Cassini-Huygens mission. Cassini launched in 1997 and arrived at Saturn in 2004.*

Cassini's first order of business was to release the European Space Agency's (ESA) Huygens probe toward the mysterious, gas-shrouded moon, Titan.



The mission was named for two 17th century scientists that made important observations of Saturn in the early days of astronomy.**



*see Issue #3 for some important observations Cassini made en route.
** see Issue #1

Nobody knew what Huygens would see on its dramatic descent!

As the probe transmitted data from its six instruments, people on Earth held their breath.

Huygens captured spectacular images, showing that Titan had some remarkably Earth-like features, such as lakes and drainage canals.

There were unambiguous signs of features carved by flowing liquid. (33)

Scientists had no idea what would happen when Huygens reached the surface. Some theories suggested it would splash into an ocean of methane!

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35

In fact, Huygens images gave us a birds-eye view of what appeared to be a dark, hydrocarbon lake.

When Huygens became the first explorer to land on a world of the outer Solar System, it touched down on a soft, but solid surface. (36)

Titan is so cold that the landing site had chunks of water ice instead of rocks. (37)

As Huygens warmed the soil, it detected bursts of methane gas. (38)

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"I am so shocked!"

"I really didn't expect the images to be so easily interpretable."

"I thought we'd see patterns... and I thought they'd still be mysterious to us."

Carolyn Porco, Cassini Imaging Team Lead.

"But the images that we've seen... one of them is clearly a drainage pattern." (40)

Every time Cassini passes Titan on its journey around the Saturn system, new details about the moon are revealed.

Cassini has spotted features like lakes, dunes, mountains and dramatic storms that make Titan seem almost 'Earth-like.'

As with Venus, Titan's environment can be used to study our own planet, Earth, through the science of comparative planetology.*

Instead of water, Titan's lakes and seas are filled with a liquid mixture of 'hydrocarbons'—carbon-based molecules like ethane and methane!

Astrobiologists are still studying what liquid hydrocarbons on Titan could mean for life's prospects on the surface...

On Earth, methane is usually found as a gas—but it's so cold on Titan that methane rains down as a liquid.

...but the moon could also have other habitats for life.

By watching how Titan is squeezed by the gravity of Saturn, Cassini may have found evidence that Titan harbors a subsurface ocean of liquid water. (42)

"The tides on Titan pulled up by Saturn aren't huge compared to the pull the biggest planet, Jupiter, has on some of its moons."

"Cassini's detection of large tides on Titan leads to the almost inescapable conclusion that there is a hidden ocean at depth." (43)

"But, short of being able to drill on Titan's surface, the gravity measurements provide the best data we have of Titan's internal structure." (43)

Sami Asmar, Cassini team member, NASA JPL

Luciano Iess, Cassini team member, University of Rome

*see Issue 3

Cassini has returned spectacular data from other locations as well. Saturn's rings have never been seen in such detail.

And dozens of Saturn's bizarre and numerous moons had their moment in front of Cassini's lens.

Tiny Enceladus captured the attention of astrobiologists when Cassini witnessed icy plumes erupting from the moon.

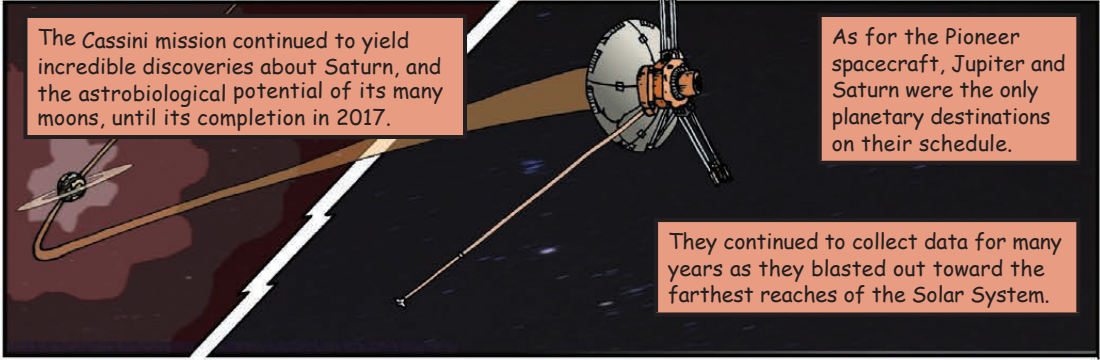
It was definitive evidence that Enceladus was geologically active.

"For planetary explorers like us, there is little that can compare to the sighting of activity on another solar system body. This has been a heart-stopper, and surely one of our most thrilling results." (44)

Cassini found evidence that the plumes contain saltwater and organic chemicals. Could Enceladus also be hiding a subsurface ocean? And could that ocean be a habitat for life? (45)

Carolyn Porco, Cassini Imaging Team Lead.

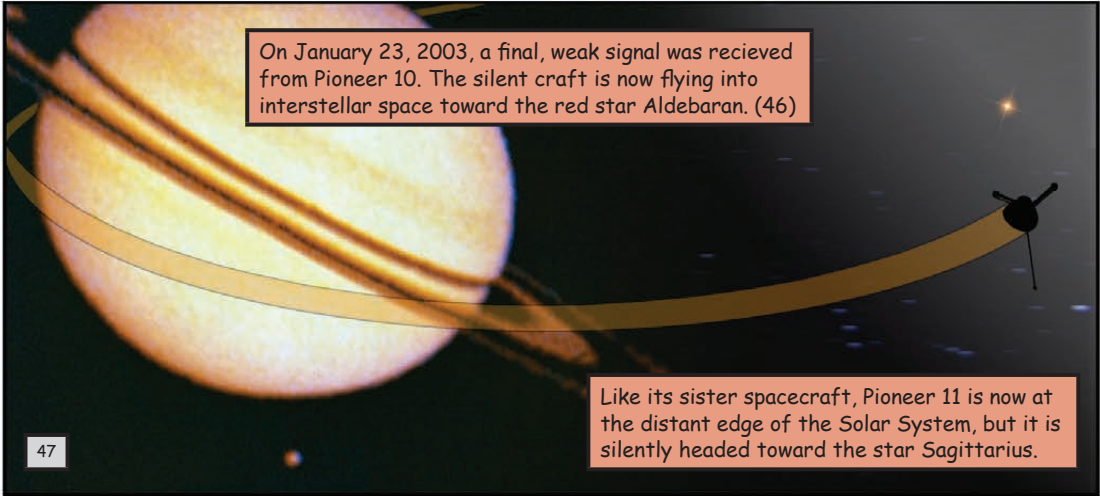
Cassini has continued to study Enceladus' plumes and their effects as they spray material all over the Saturn system.



The Cassini mission continued to yield incredible discoveries about Saturn, and the astrobiological potential of its many moons, until its completion in 2017.

As for the Pioneer spacecraft, Jupiter and Saturn were the only planetary destinations on their schedule.

They continued to collect data for many years as they blasted out toward the farthest reaches of the Solar System.



On January 23, 2003, a final, weak signal was received from Pioneer 10. The silent craft is now flying into interstellar space toward the red star Aldebaran. (46)

Like its sister spacecraft, Pioneer 11 is now at the distant edge of the Solar System, but it is silently headed toward the star Sagittarius.

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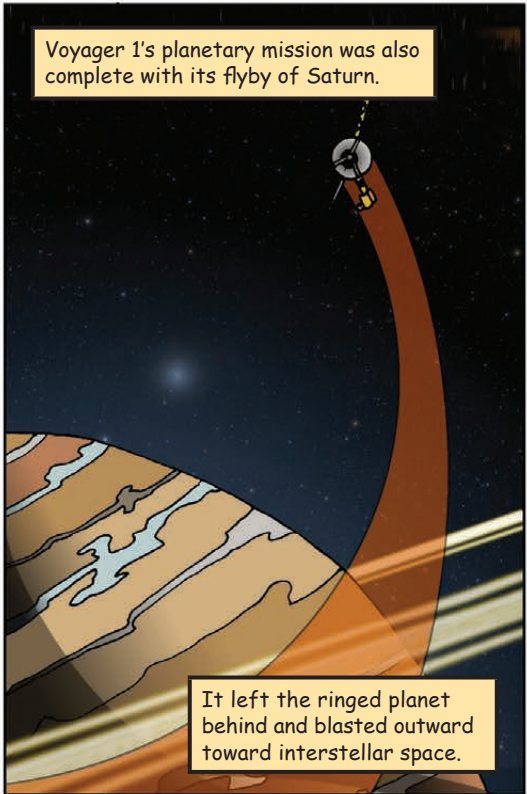


"Originally designed for a 21- month mission, Pioneer 10 lasted more than 30 years... I guess you could say we got our money's worth." (7)

"We can say that we sent Pioneer 10 off to tweak a dragon's tail, and it did that and more. It gave it a really good yank and... it survived." (2)

Robert Kraemer, NASA HQ

Larry Lasher, Pioneer Project Manager



Voyager 1's planetary mission was also complete with its flyby of Saturn.

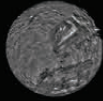
It left the ringed planet behind and blasted outward toward interstellar space.

Voyager 2, however, had more work to do.

While Voyager 1 rocketed away, Voyager 2 continued to Uranus and Neptune and completed the original 'Grand Tour' of the planets proposed in the 1960s (see page 3).



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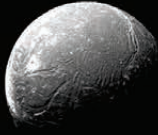
Uranus and Neptune can be seen by telescopes on Earth, but scientists didn't know what to expect when Voyager 2 arrived.



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Uranus itself appeared to be fairly inactive, with little variation in its layers of clouds.

But Voyager 2 discovered 10 new moons and 2 new rings around the planet. (14)



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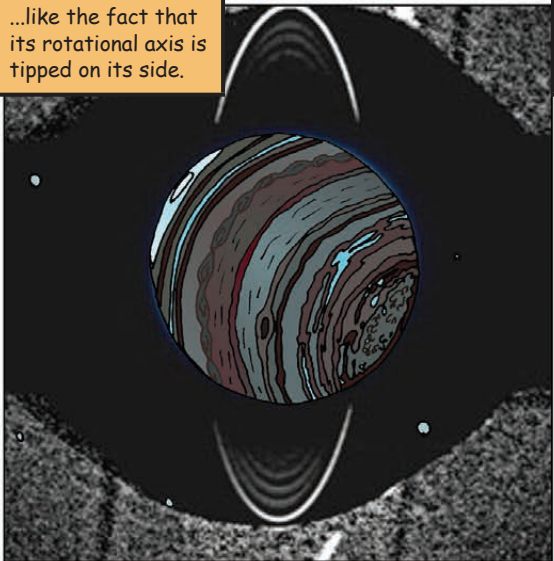
Uranus' five largest moons showed complex surfaces that indicated past geological activity.



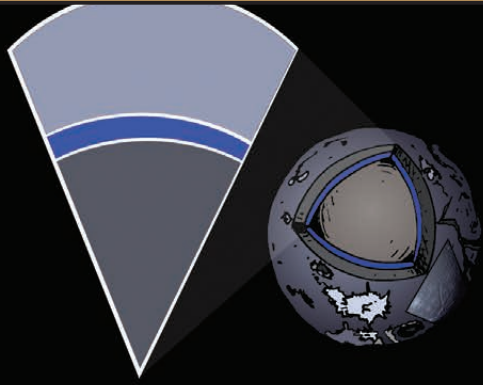
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Uranus may have looked boring at first, but it actually has some pretty strange features...

...like the fact that its rotational axis is tipped on its side.



Telescopes on Earth have revealed clouds and huge wind storms, proving that Uranus is more dynamic than it first looked in Voyager images. (53)



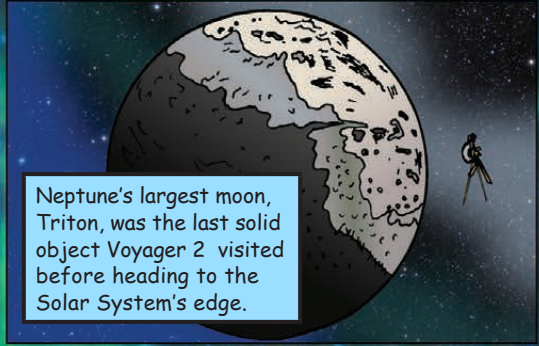
Some studies even suggest that moons of Uranus, like Titania, might have subsurface oceans. (54)

In the summer of 1989, Voyager 2 made it to Neptune. (14)



55

Neptune's largest moon, Triton, was the last solid object Voyager 2 visited before heading to the Solar System's edge.



Uranus and Neptune provide important information about the different types of planets that exist in the Universe.

"Uranus is a type of a planet that we know very little about. Thirty years ago we thought Uranus and Neptune were just smaller versions of Jupiter and Saturn." (54)

Scientists now know that they are 'ice giants,' a class of planet that might be the most common around stars other than our sun. (54)

"We'd like to study our local examples of this common type of planet." (54)

Mark Hofstadter, planetary scientist, NASA JPL

Many scientists have called for new missions to these mysterious giants.

"When Voyager flew by Uranus in 1986, it was dead. There were maybe 10 clouds."

Heidi Hammel, planetary astronomer, Association of Universities for Research in Astronomy.

"Well, that's not what it's like right now. It's in a completely different season. The atmosphere's turning on. There's dark clouds and there's bright spots and there's all kinds of activity on this planet." (56)

But with no new missions planned, Uranus and Neptune are keeping their secrets for now.

With Voyager 2, all of the major planets in the Solar System have been visited.

Jupiter and Saturn have even been orbited by spacecraft.

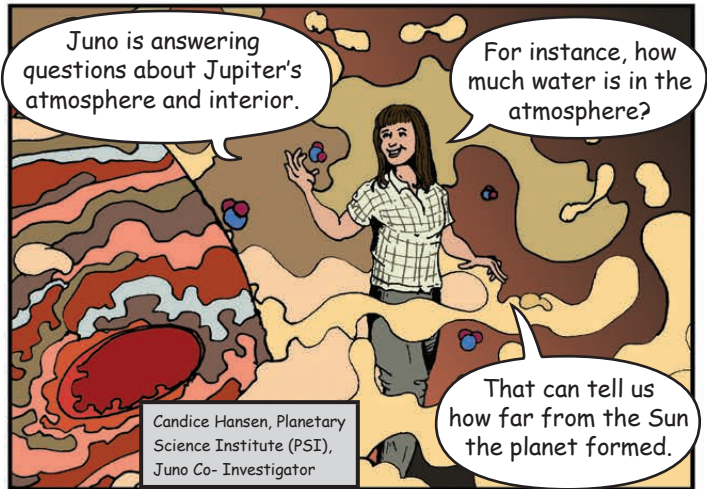
On July 4, 2016, Jupiter welcomed a new, dedicated mission, named Juno.



Juno has given us a view of Jupiter that we've never seen before.

It's the first craft to fly from pole to pole around an outer planet.

Scott Bolton, Southwest Research Institute (SwRI)
Juno principal investigator.



Juno is answering questions about Jupiter's atmosphere and interior.

For instance, how much water is in the atmosphere?

That can tell us how far from the Sun the planet formed.

Candice Hansen, Planetary Science Institute (PSI),
Juno Co-Investigator



We want to know how the Solar System formed, and Jupiter can help tell us.

After all, understanding formation is the first step in figuring out how our system became habitable.

In that sense, Juno could provide context for astrobiology studies in the Solar System and beyond.

Jonathan Lunine, Cornell University,
Juno Co-Investigator

Fran Bagenal, Univ. of Colorado, Juno Co-Investigator

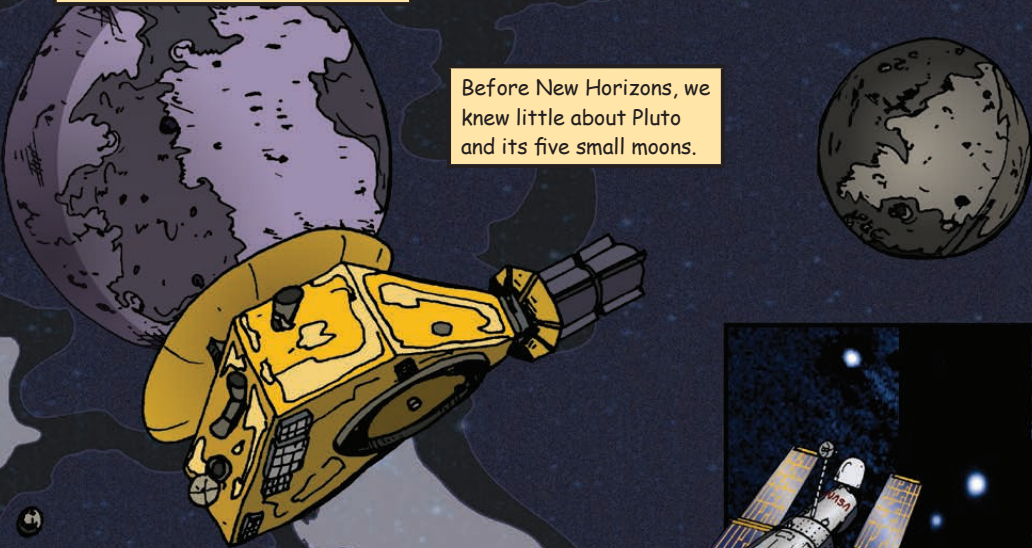
Beyond the major planets, many hidden corners of the outer Solar System remain unexplored...



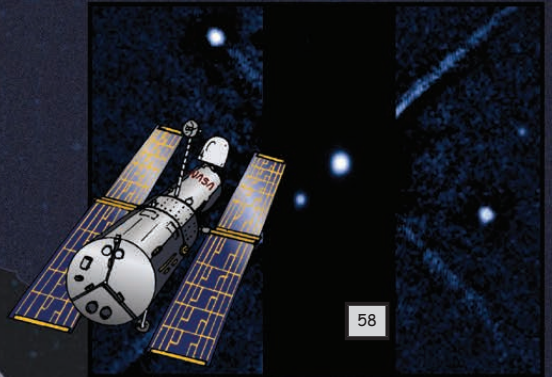
...but NASA's New Horizons mission is helping to change that.

In 2006, New Horizons launched toward small, distant Pluto, which is classified as a 'dwarf planet.'

Before New Horizons, we knew little about Pluto and its five small moons.



Even the highest-resolution images from ground-based and orbital telescopes see these tiny, distant objects as little more than points of light.



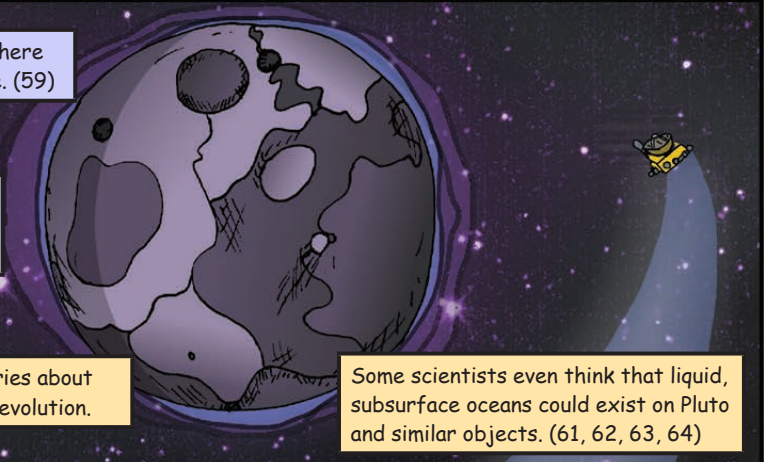
58

Pluto does have an atmosphere that is escaping into space. (59)

However, the atmospheric escape was slower than scientists had expected before the mission. (60)

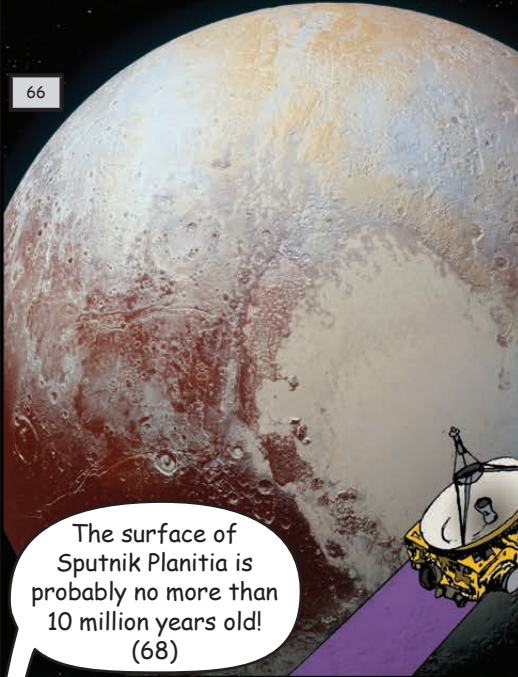
There are many theories about Pluto's structure and evolution.

Some scientists even think that liquid, subsurface oceans could exist on Pluto and similar objects. (61, 62, 63, 64)



New Horizons returned spectacular images of the Pluto system. These first-ever closeups held many surprises. (65)

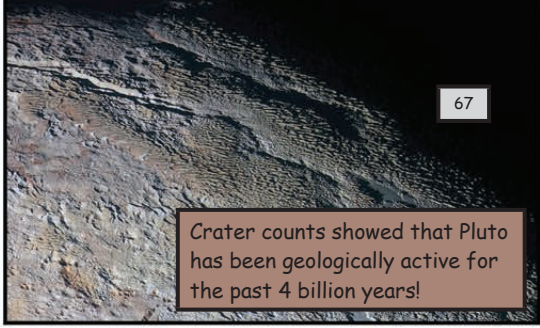
66



The surface of Sputnik Planitia is probably no more than 10 million years old! (68)

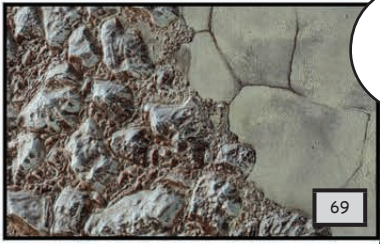
The composition of Pluto's surface is frozen, but surprisingly complex.

67



Crater counts showed that Pluto has been geologically active for the past 4 billion years!

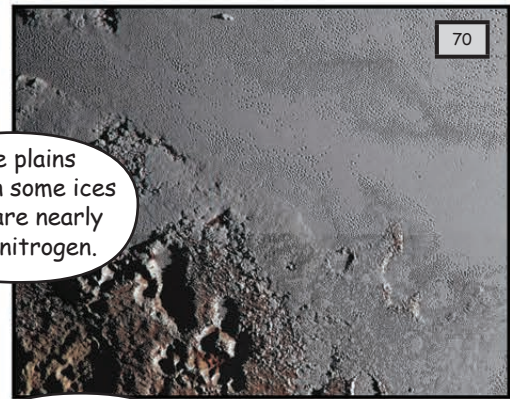
A huge ice plain larger than Texas, informally dubbed Sputnik Planitia, has no craters. This means it is geologically young.



69

There are also Methane- and water-rich areas on Pluto.

The plains contain some ices that are nearly pure nitrogen.



70

And reddish-brown areas that might be tholins! (71)



The surface variations are a real surprise.

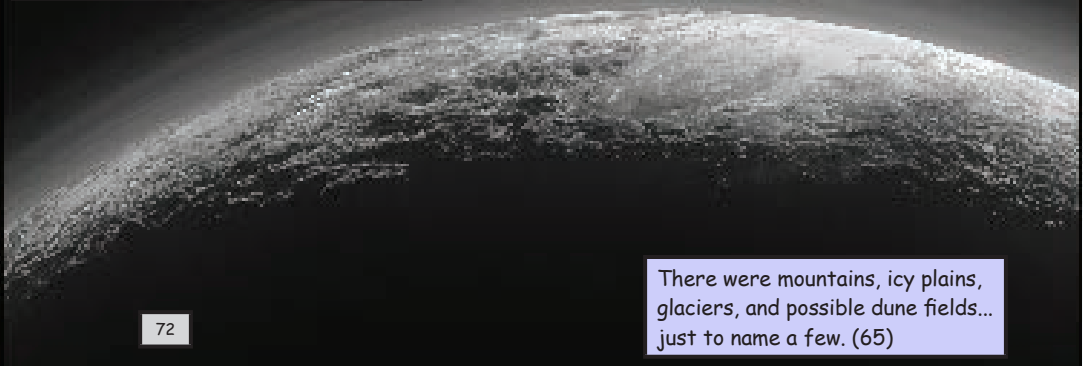
Pluto is truly unlike anywhere else in the Solar System.

Alan Stern, SwRI, New Horizons Principal Investigator

Leslie Young, SwRI, Deputy Project Scientist

Cathy Olkin, SwRI, Deputy Project Scientist

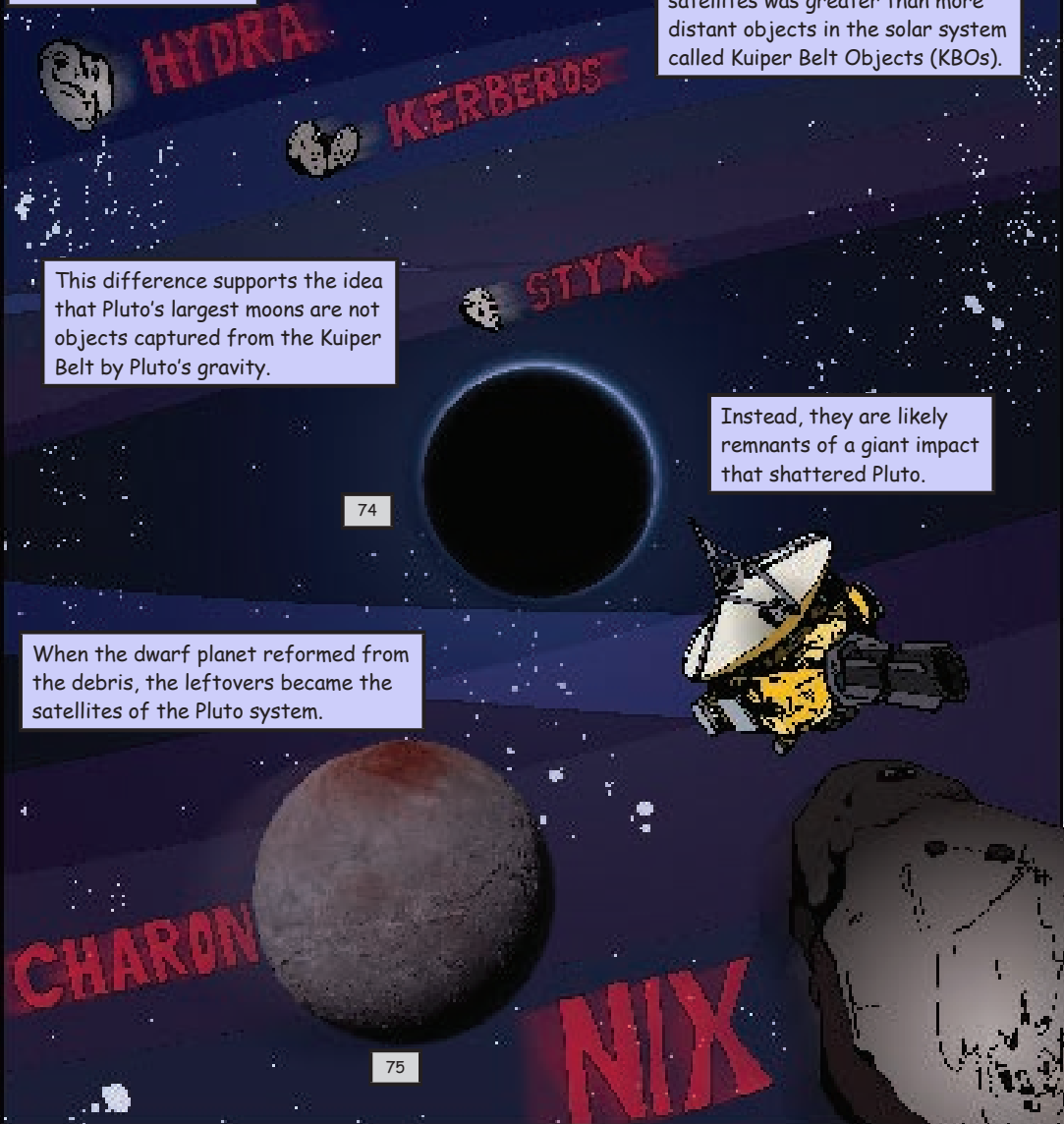
Beautiful images from New Horizons showed that Pluto's surface is covered with amazing geological features.



72

There were mountains, icy plains, glaciers, and possible dune fields... just to name a few. (65)

Even Pluto's moons had things to teach us. (73)



The brightness of Pluto's small satellites was greater than more distant objects in the solar system called Kuiper Belt Objects (KBOs).

This difference supports the idea that Pluto's largest moons are not objects captured from the Kuiper Belt by Pluto's gravity.

74

Instead, they are likely remnants of a giant impact that shattered Pluto.

When the dwarf planet reformed from the debris, the leftovers became the satellites of the Pluto system.

75

After Pluto, New Horizons turned to look at the Kuiper Belt, where the craft made observations of a number of KBOs.

The Kuiper Belt is thought to be a ring of material inhabited by 'ice dwarfs.' These planetary embryos never became planets...

...but they can teach us about how our solar system formed and evolved. (76)

In 2019, New Horizons will reach the object 2014 MU69, another example of an early building block of the Solar System.

 A diagram of the Kuiper Belt. At the center is the Sun, represented by a yellow and orange sphere. A horizontal plane passes through the Sun, representing the ecliptic. A thick, dark ring of small grey spheres represents the Kuiper Belt, located between approximately 30 and 50 AU from the Sun. A green wireframe sphere is superimposed on the scene, with the Kuiper Belt ring passing through its center. Several larger, more detailed objects are scattered around the ring, some showing different colors and textures.

Objects in the Solar System's outer reaches are not just balls of rock and ice. They actually appear in a range of colors - red, blue and white.

The dark colors are caused by radiation blasting their surfaces.

Pluto has shown us that some KBOs can be active.

For instance, white KBOs might have fresh material erupting from layers below the surface. (77)

 An illustration of a large KBO with a red and white mottled surface. A plume of white material is erupting from the top of the KBO. In the background, several other smaller KBOs are shown in various colors: blue, red, and white. The Sun is visible in the upper right corner.

Out beyond the Kuiper Belt is thought to be a mysterious region of dust and debris known as the Oort Cloud.*

* Possibly 10 to 10,000 times as far!

This distant region may be a source of comets and other objects...

 An illustration of a comet with a long, bright white tail streaking across a dark space. In the foreground, there is a large, grey, irregularly shaped rock or debris fragment. The background is filled with smaller grey rocks and dust particles.

...which can occasionally come crashing into the inner Solar System and impact worlds like Earth.

 An illustration showing a comet streaking towards Earth. The Sun is in the upper left, and Earth is in the upper right. A large, blue and white comet is shown in the foreground, moving towards the right. The background is a dark space with stars and other celestial bodies.

As robotic explorers traversed the planets of the outer Solar System, they also pointed their cameras back toward home.

"Look again at that dot. That's here. That's home. That's us."

Carl Sagan

Voyager 1 was the first to photograph Earth as a 'pale blue dot,' and showed astrobiologists exactly what an inhabited planet looks like from a distance of 6.4 billion kilometers (78).

"On it everyone you love, everyone you know... ..every human being who ever was... ..the history of our species lived there-on a mote of dust suspended in a sunbeam." (79)

The Voyagers gave us an outsider's perspective of Earth...

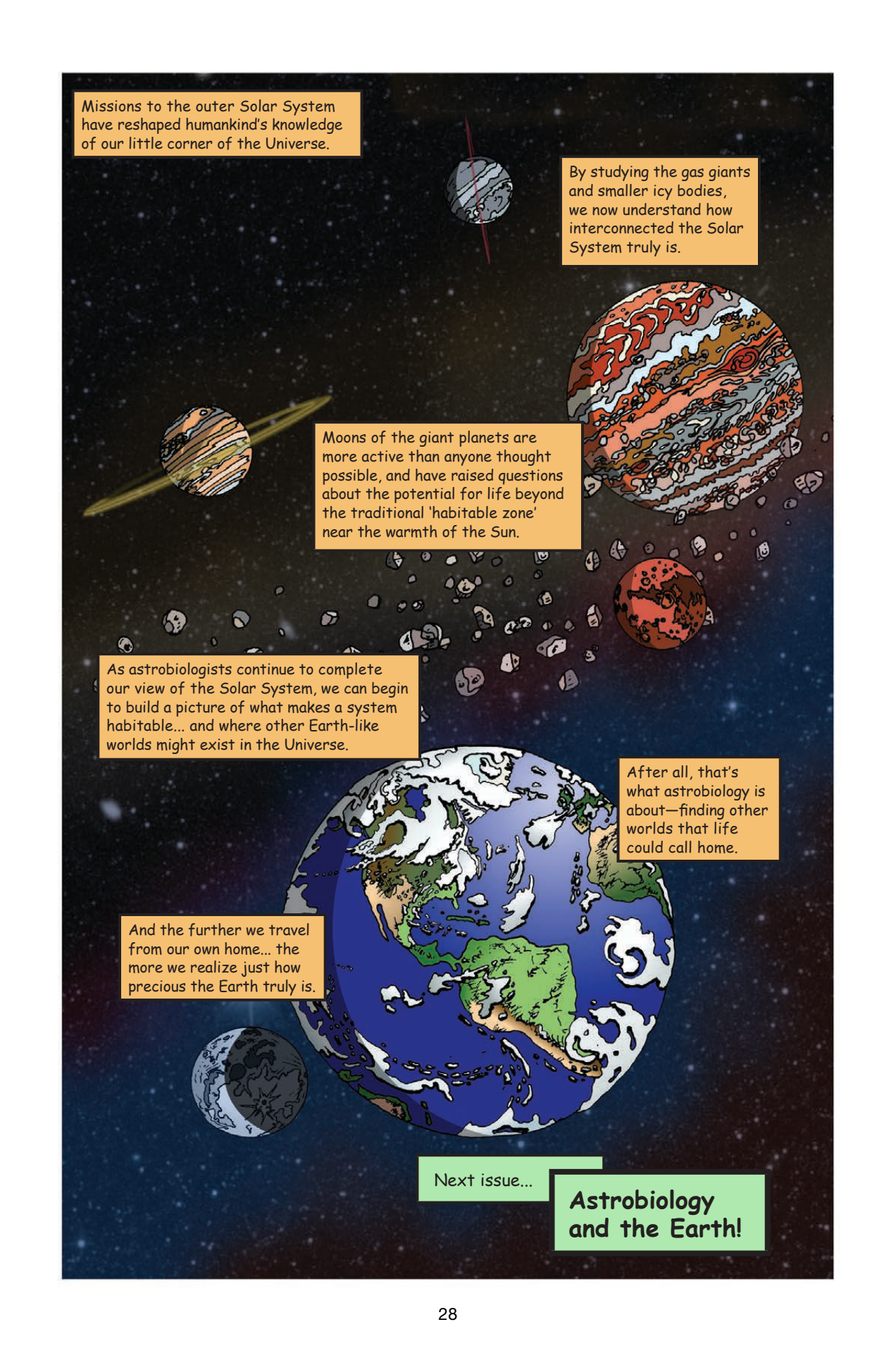
...and now they are about to do the same for our entire solar system.

More than three decades after launch, the Voyagers are still active. Voyager 1 is now the farthest-traveled object ever created by humankind.

In 2013, NASA announced that Voyager 1 had officially exited the Solar System and entered interstellar space. (80)

Together, the Voyagers are providing information about how our solar system evolved into the only known system capable of supporting life. This information can help astrobiologists spot similar systems around distant stars.

As they travel into the darkness beyond the influence of our sun... who knows what mysteries the Voyagers will uncover next!



Missions to the outer Solar System have reshaped humankind's knowledge of our little corner of the Universe.

By studying the gas giants and smaller icy bodies, we now understand how interconnected the Solar System truly is.

Moons of the giant planets are more active than anyone thought possible, and have raised questions about the potential for life beyond the traditional 'habitable zone' near the warmth of the Sun.

As astrobiologists continue to complete our view of the Solar System, we can begin to build a picture of what makes a system habitable... and where other Earth-like worlds might exist in the Universe.

After all, that's what astrobiology is about—finding other worlds that life could call home.

And the further we travel from our own home... the more we realize just how precious the Earth truly is.

Next issue...

Astrobiology and the Earth!

Astrobiology

A History of Exobiology and Astrobiology at NASA

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